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Epidemic Catarrhal Jaundice. 229

By W. G. BOOTH, M.B., B.S. Lond., M.R.C.S., L.R.C.P., D.P.H, Assistant County Medical Officer of Health, Surrey; and C. C. OKELL, M.C., M.B., M.R.C.P., D.P.H., Wellcome Physiological Research Laboratories, Beckenham, Kent.

A number of questions have been raised with regard to the occurrence of cases of jaundice of this type, and these two contributions dealing with the clinical and pathological aspects of the condition will be read with interest. Both papers were submitted at a meeting of the Home Counties Branch of the Society on November 4th, 1927.

DR. W. G. BOOTH.

THE occurrence of an infectious disease in a school is a matter of importance to all school medical officers. Should the infectious disease assume epidemic form, and the literature on the subject be found to be scanty, the school medical officer is faced with a perplexing problem. It was owing to these circumstances that the facts collected from the Surrey outbreaks of epidemic catarrhal jaundice were considered to be worthy of detailed record.

The name epidemic catarrhal jaundice given to the disease by Cockayne in 1912, is retained for the purposes of description. An investigation into an outbreak of jaundice among children at a small rural school at Longcross, near Chertsey, in December 1926, led to the notification of all cases of jaundice absent from schools of the Surrey County Council. This notification took effect from April 1st, 1927, to the end of July, 1927. It resulted in 106 cases being notified. The investigations which arose from them form the basis of this paper. I do not propose to give any particulars of the pathological examinations, which will be dealt with in more detail by Dr. Okell in the paper which follows.

The Longcross Outbreak. — Longcross; situated about three miles from Chertsey, is a purely rural area. The houses are scattered and the children well cared for and well clothed. The school is completely isolated from any other buildings; it is a well-built brick school, consisting of two rooms well lighted and ventilated. The number attacked by jaundice was seventeen. The number of children attending the school is forty-nine.

Case 1.—The first case occurred in a girl aged thirteen, living about a mile from the school. She complained of abdominal pain, headache and sickness on August 18th and 19th, 1926. Jaundice developed on August 20th. This passed off in a few days, and no doctor was called in to see her. No history of contact with a case of jaundice could be obtained.

Case 2.—On September 27th, the younger brother, aged five, of the above girl, developed abdominal pain, headache and nausea. This continued until jaundice developed on October 2nd. This was diagnosed by their own doctor. This boy slept in the same room as his sister.

Case 3.—The next case was a girl aged seven, who sat in the next seat to case 2, in school; she had diarrhœa, headache and sickness for one week from October 20th to October 27th, when jaundice developed; this was diagnosed by their own doctor.

Case 4.—A boy, aged eleven years, living in a different direction from any other school children, had abdominal pain and headache on October 28th, 1926; headache continued for four days. The urine was red on October 30th. Jaundice was diagnosed by their own doctor on November 1st.

Case 5.—A boy, aged seven years, also sat next to case 2. Sickness on November 1st—there was no headache in this case. He became progressively worse, and on November 5th, jaundice was diagnosed by their own doctor. Slight conjunctival jaundice was present when the boy was examined on December 9th.

Case 6.—A boy aged eleven years, brother of case 3. Sickness and diarrhœa commenced on November 5th, headache developed on November 6th, jaundice appeared on November 12th, and was diagnosed by their doctor.

Case 7.—A girl, aged nine years, sister of case 3, sleeps with case 3. Sickness and diarrhœa commenced November 12th, headache was present on November 12th, 13th, and

14th. Jaundice appeared on November 19th, and was diagnosed by their own doctor.

Case 8.—A girl, aged seven years. Abdominal pain on November 19th. No motion from November 19th to the 21st. Anorexia, headache, urine dark, November 21st. Headache more severe, conjunctiva yellow, November 23rd. Motion white, headache less severe on November 24th; skin yellow, no headache November 25th; urine less dark, another white motion on November 26th; urine clear on the 27th; appetite returned 28th; motion normal on the 29th. These details were given by the mother, once a trained nurse, who had taken notes of the illness. A doctor was in attendance.

The other nine cases may be shortly described. All commenced with headache, sickness with or without abdominal pain and clay coloured motions. Dark urine and jaundice appeared on the first or second day following.

Case 12 was a sister of case 5. Case 14 slept with his brother, case 5. Case 16 was a school teacher, and case 17 was a sister to case 9.

No enlargement of liver or spleen was detected in any instance. The cases spread over a period from November 17th to December 12th, the longest interval without a new case being from December 7th to December 20th.

The urine of all cases after case 8 was examined on December 20th; no albumen was found in these seven cases. The urine from cases 15, 16 and 17 was examined on the day the patients were seen by me; no albumen was found. In the seventeen cases, vomiting occurred in thirteen, headache in eleven, abdominal pain in seven.

During this investigation I learned that other epidemics of jaundice among children had occurred during 1925 at Addlestone, three miles from Longcross. The Health Visitors were therefore requested to notify me of any cases of jaundice occurring among school children in my area.

Pyrford Outbreak.—The second outbreak consisted of three cases at Pyrford School. This school is a small village school of a similar type to Longcross, situated three miles from Byfleet, and eight miles from Longcross. All three cases occurred in one family. They lived in a disused pigeon house by the Basingstoke Canal, and, working on the lines that the disease might be due to infection with leptospira icterohæmorrhagiæ, it was thought that the disease might have come from the canal water. The family consisted of the mother, father, and three children—two boys aged ten and six respectively, and a girl aged five. Owing to tar having been put down the well, the family used the canal water for drinking and household purposes; it was never boiled. On January 22nd, 1927, the younger boy, aged six, had abdominal pains; he vomited once or twice on the 22nd, 23rd, and 24th. He became jaundiced on the 24th. No history of contact with any case of jaundice could be traced. Five specimens of canal water and slime from the mud at the water's edge were examined by Dr. Okell, who found no evidence of the presence of virulent leptospiras. On the ninth day of illness, I took a specimen of urine. This day was chosen as Hindle and Brown[5] found a leptospira in the urine of a case of jaundice in a child on this day. This was negative for leptospiras. The mother was requested to isolate the affected child, and to keep the other children away from school for a month. On February 25th, 1927, the other two children developed jaundice. On interviewing the mother, I learned that the attack in both children was in every way similar to that of the first child affected.

The attacks commenced with abdominal pains mainly on the right side, but extending across the epigastrium; headache and vomiting came on a day after the abdominal pain and continued for about two days; jaundice then appeared. The girl aged five was worse than the boy aged ten, but neither was sufficiently ill to take to their beds, and no doctor was called in to attend them.

These Pyrford cases were fairly typical of all the cases which had gone before and occurred since. No further cases occurred at Pyrford.

Brockham Betchworth Outbreak.—The first epidemic we found from our scheme of notification was at Brockham Betchworth. Here we found that a number of cases had occurred in March, 1927, just prior to our scheme of notification. On enquiry, it appeared that on October 18th, 1926, the outbreak commenced with a boy aged twelve. He was visited by a health visitor, and excluded from school until November 15th, 1926. On November 8th, 1926, a younger brother developed the disease, and was absent from the school until December 13th, 1926, when he appeared to have quite recovered.

On January 11th, 1927, a child was seen at a medical inspection, and appeared to be unwell; it was diagnosed as digestive trouble due to over-eating. On January 14th, the child was definitely jaundiced, and was excluded from school. This child sat next to the second case reported who was taken ill on November 8th, and returned to school on December 13th, 1926. On February 11th, another girl developed jaundice; another five cases then occurred in rapid succession on March 9th, 10th, 14th, 17th, and 18th, about a month after the previous case.

On enquiry into the clinical history of these eight cases, a history of headache about four days prior to the jaundice was obtained in four cases, while in every case either sickness or nausea occurred from two to four days prior to the jaundice.

An enquiry into the origin of the outbreak led me to investigate a well, the water from which the first case, which occurred on October 8th, drank in September, 1926; he described it as thick. A specimen was examined for the typhoid-paratyphoid group of bacteria and for virulent leptospiras, but was negative for these micro-organisms.

Egham Hythe Outbreak. — Another epidemic was discovered at Egham Hythe; this is really a part of Staines, but it is on the Surrey side of the river. Most of the cases were attended by Staines practitioners, and they were kind enough to give me details of numerous cases which occurred in the Staines district. I gathered that the disease was prevalent in Middlesex to a similar degree to that in Surrey. Their cases were similar clinically in every respect to the Surrey cases.

The first case in Egham Hythe occurred on February 8th, 1927, when it was diagnosed as influenza with abdominal pain; on February 14th, this boy, aged thirteen, attended school and whilst sitting in school during the morning was noticed to be jaundiced. The jaundice, in spite of the comparatively mild onset, lasted four weeks, and the boy returned to school on April 21st, 1927. Meanwhile, on March 15th, another boy developed abdominal pain while at school. He remained at school until March 18th, and on March 20th, he developed jaundice. Two more cases occurred on March 21st and 25th. On April 8th, the sister of the boy who had abdominal pain on March 15th, developed jaundice. Four cases then followed rapidly. A girl, aged twelve, had a feverish cold on April 18th, which developed to a severe pain in the right epigastrium on the 21st, and jaundice appeared on the 25th. Another girl, aged twelve, had a " bilious attack " on April 22nd, attended school on the 25th, but on the 26th she had a headache and abdominal pain. Jaundice developed on the 28th. Two children aged seven and six respectively, were jaundiced on April 26th and 30th, with similar symptoms.

On May 6th, 18th, 24th, 29th, and 30th, five infants under eight years of age were affected with similar symptoms. There were fourteen cases in all.

Caterham Outbreak. — There are three schools at Caterham, one in the Valley and two on the Hill. One of the schools on the Hill had only two cases of jaundice. In the other two schools, from September, 1926, to July, 1927, there were twenty-five cases at the Hill school—a school of 600 children—and from January, 1927, to July, 1927, there were twenty-one cases at the Valley school—a school of 150 children.

Our investigation commencing in April, 1927, it was with some difficulty that we traced the commencement of the outbreaks.

The first case occurred at the Hill school on September 1st, 1926, but, owing to the time which had elapsed, no details of the illness or contact with any other case could be found. Cases followed on October 7th, 15th, 28th and 29th, nine cases occurred in November, three in December, 1926, one case in January, 1927, no cases in February, one case in March, one case in April, four cases in May, and one case in June. The epidemic in this case seems to have had two peaks; one in November, 1926, and one in May, 1927. In this outbreak one boy affected on October 15th, 1926, was a brother of a boy affected twenty-five days later.

One boy was affected on November 19th, 1926, and his sister was affected twenty days later. Another brother and sister were affected within forty days of each other.

In the Valley outbreak the first case occurred on February 7th, 1927; the second case on March 10th, 1927. Ten cases occurred in April (three of these, one on April 5th, and two on April 10th, were brother and sisters of the case which occurred on March 10th, that is, twenty-six days and thirty days intervals respectively). Six cases occurred in May, two in June, and one in July.

As a part of the investigation into the cause of this disease it was decided to take specimens of venous blood from the arms of cases actually jaundiced. This was done at Caterham on May 3rd. The cases were both on the sixth day of illness and the third day of jaundice.

After consultation with Dr. Okell it was decided to obtain specimens from a case in the pre-icteric stage of the illness. On May 27th, 1927, a child was excluded from school by the health visitor with suspicious symptoms of headache, nausea and abdominal pains. The child had a temperature of 103°. She had passed no motion for three days, and had no appetite for several days. On the night of the 27th she had some delirium. I examined her on the 28th; there was no pain, no abdominal tenderness; no enlargement of the liver or spleen was felt; her temperature was 99°. She was ordered to stay in bed; specimens of blood and urine and a throat swab were taken. These were despatched to Dr. Okell. The child developed jaundice on May 31st, 1927, five days after the onset.

Incubation Period.—As it is most important in a disease of unknown etiology to make certain, as far as possible, of the incubation period, details are given of every initial two cases in the six outbreaks investigated. In every case enquiries were made as to the possibility of infection being conveyed from any other than the initial case, but no contacts were traced. In the Longcross outbreak, the first case occurred on August 18th, the second case, a brother of the first case, on September 27th, an interval of forty days. At Pyrford, the first case occurred on January 22nd, the second and third cases, brother and sister of the first case, on February 25th, an interval of thirty-three days. At Brockham Betchworth the first case occurred on October 18th, the second case, a brother of the first case, occurred on November 8th, an interval of twenty-one days. At Egham Hythe the first case occurred on February 8th, the second on March 15th, an interval of thirty-five days. At Caterham Hill, the first case occurred on September 1st, the second case on October 7th, an interval of thirty-seven days. At Caterham Valley the first case occurred on February 7th, the second case on March 10th, an interval of thirty-one days. Here we have six intervals of twenty-one days, thirty-one days, thirty-three days, thirty-five days, thirty-seven days and forty days, three of these being between brothers. An interesting case, that of the son of the Valley School Headmaster, occurred on May 17th, 1927. This boy attended the public school at Caterham, and was not in contact with any of the children at the Valley School except on one occasion when he played with a boy who developed jaundice six days later. This contact was on April 16th, and jaundice appeared on April 22nd. The Headmaster's son developed jaundice on May 17th—an interval of thirty-one days. From this one is led to suspect that the infection is potent prior to any symptoms appearing in the affected person. *These observations suggest that the incubation period of the disease is not more than forty days nor less than twenty days.*

I have purposely avoided giving incubation periods during the epidemics, as the date of contact must necessarily often be vague.

School Distribution.—The schools at which epidemics occurred were widely distributed across the county, and there seemed small probability of any cases conveying infection from one school to another. Other facts which emerged as a result of our scheme of notification was that between April and July, 1927, we had from eleven separate schools notifications of one case only; from one school two cases, from four schools three cases, from one school five cases and from one school six cases.

Age Incidence.—The age incidence of the disease was as follows: Aged four years, two cases; aged five, fifteen cases; aged six, sixteen cases; aged seven, fourteen cases; aged eight, twelve cases; aged nine, nine cases; aged ten, seven cases; aged eleven, nine cases; aged twelve, twelve cases; aged thirteen, seven cases; aged fourteen, three cases. This makes a total of 106 cases; the number of families with two or more children affected in one house was fifteen. Only one case in an adult was investigated—that was in the Longcross outbreak—and this occurred in a teacher aged twenty-four years. Only a few young adults were reported by the local practitioners to have been affected at Caterham. The disease seems therefore, to affect children almost exclusively.

Symptomatology.—The question of clinical data I have lightly touched upon; it was impossible in my capacity as Assistant County Medical Officer to watch the clinical side of these outbreaks with the care and caution of a whole-time investigator, but the cases I saw convinced me that they were all very similar in their main characteristics. The question of initial rise of temperature is an interesting one. At Egham Hythe I requested the Head Teacher to take the temperature of any child who showed signs of illness in school. One case of jaundice which developed later in the same day was found to have a temperature of 102° in the morning. At the time the temperature was taken at school the child was found to have stomach pains, headache, and a coated tongue. No other cases were discovered in school at Egham. The only other definite case of jaundice in which the temperature was taken was at Caterham, where the child was unwell in the morning. The health visitor took the temperature at 2 p.m.—it was 103·4°; the next day it was 99°. The jaundice developed five days later. Both of these children were aged six years. This initial rise of temperature rapidly subsides, and I was unable to find any elevation of temperature in cases with jaundice that came under my notice. The difficulty of obtaining this temperature, which occurs from one to five days prior to the jaundice, probably led Morgan and Brown[2] in their report to say: "the fever seldom amounts to more than 100° F. or 101° F."

The clinical picture presented in this disease is a prodromal stage, lasting three or four days, of constipation and loss of appetite, occasionally diarrhœa taking the place of the constipation. This is followed by a sudden sharp rise of temperature up to 103°., abdominal pain, chiefly on the right side, nausea, vomiting, and headache occurring in about 50 per cent. of the cases. Delirium may occur the same day. This stage of the disease is usually diagnosed as "gastric influenza." The symptoms rapidly subside the following day and the child appears to be much better. No albumen is found in the urine at this stage, and there is no enlargement of liver or spleen. From two to five days later jaundice develops first in the conjunctivæ and then over the whole body. The urine is dark and the stools are clay coloured. This passes off within a few days, and the child appears to be quite well. In severe cases the jaundice may last two or three weeks. The general course of the disease is mild in character.

Summary.—An epidemic type of infectious jaundice has been found to be prevalent in various parts of Surrey. It is characterised by an initial rise of temperature, associated with abdominal pain and vomiting; a subsidence of symptoms within forty-eight hours; the appearance of jaundice from two to five days after the initial symptoms and an apparently complete recovery. It is almost exclusively a disease of children, and is mild in character. This disease constitutes a defined clinical entity—that of the epidemic catarrhal jaundice described by Cockayne[1] in 1912. The incubation period would appear to be between twenty and forty days.

I cannot close this paper without expressing my deep gratitude to Dr. Cates for the unfailing help and encouragement given me in this investigation.

DR. C. C. OKELL.

Though for some years past I have been interested in outbreaks of jaundice such as those described by Dr. Booth, and have made as many examinations on material from such outbreaks as I could, I am not in a position to offer any solution of the etiological problem which this interesting disease offers. At the same time, it may help discussion not only if I give an account of my own negative results, but also if I attempt to define the problem and its difficulties in the light of the meagre knowledge that is available. Put briefly the problem may be stated as follows:—

In the type of jaundice that Dr. Cockayne,[1] Dr. Booth, and Drs. Morgan[2] and Brown have described, we appear to have a definite clinical entity—an obviously infectious disease with certain characteristics of incubation and incidence. It is pre-eminently a disease of school children. So far as one can make out, the disease is fairly infectious, and several children may be infected in one household or school; speaking generally, the evidence that is available seems to suggest that direct contagion takes place from person to person. That the disease is due to some specific infecting agent there seems little ground for reasonable doubt. The disease is so benign that it is not clear that any true case of the disease has been submitted to a post-mortem examination unless it is that described by Dr. Cockayne, where, however, no evidence bearing on the etiology of the disease was elicited. In investigating such a problem as this the obvious method of attack is :—

(1) To attempt to isolate from the body of a patient the causative organism;

(2) to attempt to transfer the disease to a susceptible animal.

Now, owing to the mildness of the disease, and the fact that jaundice seems to be a symptom which occurs after the febrile stage of the disease, it was not easy to obtain materials at the right stage of the disease. In particular, Dr. Cockayne, Dr. Lemprière of Haileybury School, and Dr. Booth made keen efforts to obtain the material at the more interesting stages of the disease, but for the most part, cases were seen and diagnosed late in the course of the disease, and the promise of positive cultures or positive animal experiments was small.

The Leptospiral Theory.—To give a practical direction to the etiological enquiry one can ask oneself the question—Are these cases of epidemic jaundice really mild cases of Weil's disease and due to leptospiral infection? The incubation period—three to four weeks, as defined by Dr. Booth—is certainly compatible with the leptospiral hypothesis. Weil's disease is also characterised by a febrile preicteric stage of short duration followed by an icteric stage which is often afebrile. It may be noted that characteristic Weil's disease is much rarer in the community than the possibility of infection from rats and other sources would suggest as likely. Why is definite Weil's disease so uncommon in this country in human patients while leptospiral infection is so common among dogs (Okell, Dalling, Pugh[3 4]) and wild rats? Is it possible that the disease we are considering is a mild form of Weil's disease? At any rate, it seems to be wise to eliminate this inviting explanation before seeking for unknown etiological agents. One must bear in mind that leptospiral disease in all animals has some curious features. The typical and highly characteristic disease which occurs so commonly in experimentally infected guinea-pigs and from time to time in man and dogs is a marked and severe jaundice accompanied by a general tendency to hæmorrhages, which at autopsy are most characteristic when the lungs are affected. Some susceptible animals, however, may become infected with the disease, and, indeed, die of it without any icteric or hæmorrhagic signs. Thus in dogs and ferrets the disease is often atypical. I have recently found that of laboratory white mice nearly a hundred per cent. can be infected, either dying from the disease or becoming kidney carriers. Excepting for an occasional petechia in the lungs there were none of the characteristic signs of leptospiral infection. Leptospiral disease can, therefore, under certain conditions, be both mild and atypical. Again, it is very characteristic of leptospiral disease in any animal excepting perhaps the guinea-pig that very great difficulty may be met with in isolating the causal organism in a given case. How commonly, for example, in human Weil's disease do all efforts at isolating the leptospira fail! Dalling and I found the same, if not greater, difficulty in isolating leptospiras from dogs, either from the naturally occurring disease or even from dogs experimentally infected with leptospira. If the infecting agent were a leptospira one would indeed expect to have considerable difficulty in isolating the micro-organism from such a mild form of the disease, and one would not wisely condemn the hypothesis of leptospiral infection until the work of special examination had been very thoroughly done. If these cases were leptospiral one might expect that the serum of convalescent cases like the serum of animals convalescent from Weil's disease would contain protective antibodies against the leptospira. I have examined from this standpoint a number of convalescent sera provided by Dr. Cockayne, Dr. Lemprière and Dr. Booth, but not even in large (3 cc.) doses was there any evidence of a protective antibody.

In some dozen cases I have tried to infect guinea-pigs with blood and urine obtained from patients in the icteric (and possibly post-infective) stage. The animals never showed any jaundice or signs of leptospiral disease though they were carefully examined. Direct examination of the urine for leptospiras was also invariably negative. One case found in the preicteric febrile stage was examined, but was completely negative like the rest.

Blood cultures during the icteric stage and also of the one preicteric case were also negative. No parasites were seen in any blood film examined. The Widal reaction against B.Typhosus, B.Para-typhosus A, and B. Para-typhosus B was negative in all of half dozen cases examined, and no abnormal parasites were isolated from the stools.

One is left with two alternatives: either (1) the disease is not transmissible to guinea-pigs, or (2) it is leptospiral but so difficult to transfer to guinea-pigs that we have not yet had the fortune to be able to prove it. Perhaps the succession of negative findings might be taken as disposing of the leptospiral hypothesis, but the school epidemic of jaundice described by Hindle and Brown[5] was considered by these authors to be certainly due to leptospira. Its incubation period (about one month) was stated to be the same as that of the Surrey epidemics. The second, or Midland epidemic described by Morgan and Brown seems to be clinically identical with the Surrey outbreaks except that the authors believed the incubation period to be about five days. The evidence which Dr. Booth has brought forward that in the Surrey outbreaks the incubation period was approximately a month is almost unquestionable. In Morgan and Brown's outbreak no definite evidence of a leptospiral origin was forthcoming, and in this respect again it resembled the Surrey outbreaks.

As the observations of Hindle and Brown stand as positive findings among so many negative, they should, I think, be taken as a strong reason for not losing sight of the leptospiral hypothesis until much more work has been done. One objection to the leptospiral theory is that the infection appears to be more contagious between child and child than the known facts of leptospiral disease would suggest. A similar degree of contagion, however, appears to have prevailed in Hindle and Brown's leptospiral outbreak.

In connection with the Surrey outbreak, Dr. Booth and I made a fairly thorough survey of the leptospiral conditions of the epidemic. The rats from the affected localities showed a high percentage of positive carriers of virulent leptospira but this is, of course, by no means peculiar to the affected areas. Water from the Pyrford canals and other water associated with the epidemic were generally positive for water leptospira, but there was no evidence forthcoming that these were directly virulent to experimental animals. We took particular interest in the water conditions because Houston[6] and I recently satisfied ourselves that under certain conditions a water leptospira had proved virulent. Whatever was the mechanism of this change in virulence, we were satisfied that direct infection of a human being from water containing saphrophytic leptospiras is extremely unlikely. Everyone is constantly using water containing saphrophytic leptospiras, yet jaundice that could be referred to infection from this source, so far as we know, does not occur.

With regard to other alternative theories involving an already known infective agent, outbreaks of jaundice have been described from time to time in connection with infection with the enteric group of organisms. So far as our work has gone, there is no evidence of any such infection in these cases, and no clinical fact which gives it the least degree of support. Blood parasites such as relapsing fever, etc., seem also to be eliminated by our examination. Similar negative results were obtained by the Ministry of Health workers in the Midland epidemics.

It seems then that while we cannot yet completely dispose of the leptospiral theory we may suggest as an alternative the theory that the disease is due to an invisible virus which has not so far been identified. If this latter supposition is true, small animals are probably not susceptible to the hypothetical virus, and little help is likely to come from experiments at the present juncture. We can, however, put the leptospiral hypothesis to still further test by examining a larger amount of material and under conditions which would render negative evidence more conclusive than has been possible up to now. Perhaps with increasing definition of the disease from the clinical and epidemiological standpoints new facts may emerge which will give us a new line of attack on the problem of etiology. One would like to know something about the blood counts in the disease, both in the pre-icteric and icteric stages, but so far as I know no information on this subject is available. Careful study of outbreaks might also shed some further light on the method of spread of the disease which would suggest a solution of its epidemiology.

REFERENCES.

[1] Cockayne, E. A. Quar. Journ. of Med. p. 1. 1912.

[2] Morgan, M. T., and Brown, H. C., "Epidemic of Catarrhal Jaundice," Ministry of Health Reports on Public Health and Medical Subjects. No. 42. 1927.

[3] Okell, C. C., Dalling, T., and Pugh, L. P., Vet. Journ., Vol. 81, p. 1. 1925.

[4] Okell, C. C., Dalling, T., and Pugh, L. P., Proc. Roy. Soc. Med., Vol. 18. (Sect. Comp. Med.) p. 17. 1927.

[5] Hindle, E., and Brown, H. C., *Lancet*, II., p. 372. 1925.

[6] Houston, A., Metropolitan Water Board, 20th Annual Report, pp. 43-51. 1926.